US009068435B2

(12) United States Patent
Broussard et al.

(10) Patent No.: US 9,068,435 B2
(45) Date of Patent: Jun. 30, 2015

(54) GRAVEL PACK INNER STRING ADJUSTMENT DEVICE

(75) Inventors: **John P. Broussard**, Kingwood, TX (US); **Ronald van Petegem**, Montgomery, TX (US); **Christopher Hall**, Cypress, TX (US); **Patrick J. Zimmerman**, Houston, TX (US); **Brian Ritchey**, Hockley, TX (US); **Rockni Van Clief**, Houston, TX (US)

(73) Assignee: **Weatherford Technology Holdings, LLC**, Houston, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 716 days.

(21) Appl. No.: **13/345,476**

(22) Filed: **Jan. 6, 2012**

(65) **Prior Publication Data**

US 2012/0103631 A1 May 3, 2012

Related U.S. Application Data

(63) Continuation-in-part of application No. 12/913,981, filed on Oct. 28, 2010, now Pat. No. 8,770,290.

(51) **Int. Cl.**
E21B 43/04 (2006.01)
E21B 17/07 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***E21B 43/04*** (2013.01); *E21B 43/10* (2013.01); ***E21B 17/07*** (2013.01); ***E21B 47/09*** (2013.01)

(58) **Field of Classification Search**
CPC E21B 17/07; E21B 43/04; E21B 43/10; E21B 47/09
USPC 166/242.7, 381, 278, 51; 175/321
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,134,439	A	5/1964	Shields	
3,614,984	A *	10/1971	Schexnaider	66/150
4,105,069	A	8/1978	Baker	

(Continued)

FOREIGN PATENT DOCUMENTS

GB	2387401	A	10/2003
RU	1810500	A1	4/1993

(Continued)

OTHER PUBLICATIONS

Schlumberger, "Alternate Path Screens," obtained from www.slb.com/oilfield, dated Jan. 2004, 4 pages.

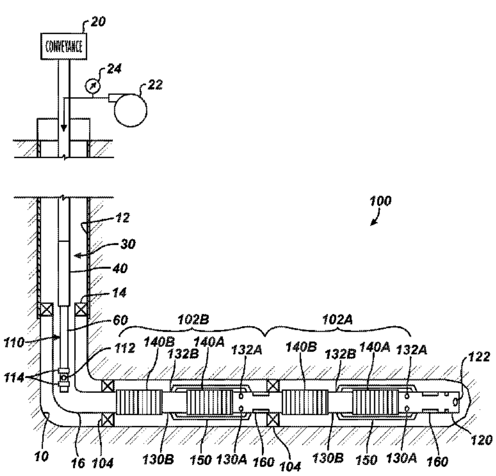
(Continued)

Primary Examiner — Nicole Coy
(74) *Attorney, Agent, or Firm* — Wong, Cabello, Lutsch, Rutherford & Brucculeri, LLP

(57) **ABSTRACT**

A downhole assembly, such as a toe-to-heel gravel pack assembly, has a body with a body passage, outlet ports for slurry, and screens for fluid returns. An inner string deploys in the body to perform the toe-to-heel gravel packing. A telescoping adjustment device allows the inner string to space out properly when deployed to the toe of the assembly. Sealing surfaces or seats of a locating device in the body separate a sealable space and seal against seals on the inner string movably disposed therein. Fluid pumped in the string produces a pressure buildup when the string's port communicates with the sealable space. The pressure buildup indicates that the tool is positioned at a first location in the assembly, and other positions for placement of the tool can then be calculated therefrom.

19 Claims, 4 Drawing Sheets



(51) **Int. Cl.**
E21B 47/09 (2012.01)
E21B 43/10 (2006.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,433,725	A	2/1984	Bowyer	
4,440,218	A	4/1984	Farley	
4,474,239	A	10/1984	Colomb et al.	
5,269,375	A	12/1993	Schroeder, Jr.	
5,413,180	A *	5/1995	Ross et al.	166/387
5,934,376	A	8/1999	Nguyen et al.	
6,003,600	A	12/1999	Nguyen et al.	
6,253,851	B1	7/2001	Schroeder, Jr. et al.	
6,349,770	B1	2/2002	Brooks et al.	
6,371,210	B1	4/2002	Bode et al.	
6,446,722	B2	9/2002	Nguyen et al.	
6,588,507	B2	7/2003	Dusterhoft et al.	
6,601,646	B2	8/2003	Streich et al.	
6,675,891	B2	1/2004	Hailey, Jr. et al.	
6,749,023	B2	6/2004	Nguyen et al.	
6,820,698	B2 *	11/2004	Haynes	166/381
6,857,476	B2	2/2005	Richards	
6,983,795	B2	1/2006	Zuklic et al.	
7,017,664	B2	3/2006	Walker et al.	
7,331,388	B2	2/2008	Vilela et al.	
7,367,395	B2	5/2008	Vidrine et al.	
7,472,750	B2	1/2009	Walker et al.	
7,798,213	B2 *	9/2010	Harvey et al.	166/242.7
8,439,122	B2 *	5/2013	Harvey et al.	166/381
2003/0000702	A1	1/2003	Streich	
2003/0037925	A1	2/2003	Walker et al.	
2003/0141075	A1	7/2003	Bixenman et al.	
2004/0134656	A1	7/2004	Richards	
2004/0211559	A1	10/2004	Nguyen et al.	
2007/0187095	A1	8/2007	Walker et al.	
2008/0099194	A1	5/2008	Clem	
2009/0095471	A1	4/2009	Guignard et al.	
2009/0133875	A1	5/2009	Tibbles et al.	
2009/0283256	A1 *	11/2009	Langeslag	166/242.7
2010/0096130	A1	4/2010	Parlar et al.	
2010/0263864	A1	10/2010	Chay et al.	
2011/0284208	A1 *	11/2011	MacLeod et al.	166/88.2

FOREIGN PATENT DOCUMENTS

RU	2374431	C2	8/2008
SU	1191563	A	11/1985
WO	2005049954	A2	6/2005
WO	2007126496		11/2007

OTHER PUBLICATIONS

Schlumberger, “FloRite—Inflow control device,” obtained from www.slb.com/transcend, (c) 2009, 2 pages.

Halliburton, “Sand Control: Horizon Low Density, Lightweight Gravel,” obtained from www.halliburton.com, (c) 2006, 2 pages.

Edment, Brian, et al., “Improvements in Horizontal Gravel Packing,” Oilfield Review, Spring 2005, pp. 50-60.

Synopsis of SPE 38640 by Jones, L.G., et al., “Shunts Help Gravel Pack Horizontal Wellbores with Leakoff Problems,” Journal of Petroleum Technology, Mar. 1998, pp. 68-69.

Coronado, Martin, et al., “Completing extended-reach, open-hole, horizontal well,” obtained from http://www.offshore-mag.com/index/article-tools-template, generated on May 12, 2010, 5 pages.

Schlumberger, “ResFlow Inflow Control Devices and MudSolv Filtercake Removal Equalize Inflow and Restart Wells,” obtained from www.slb.com/sandcontrol, (c) 2010, 2 pages.

Jensen, Rene, et al., “World’s First Reverse-Port Uphill Openhole Gravel Pack with Swellable Packers,” SPE 122765, 15 pages.

Weatherford, “Model 4P Retrievable Seal-Bore Packer Gravel-Pack System,” obtained from www.weatherford.com, (c) 2005-2009, 2 pages.

Brannon, D.H., et al., “A Single-Trip, Dual-Zone Gravel Pack System Successfully Gravel Packs Green Canyon Area Wells, Gulf of Mexico,” SPE 21670, (c) 1991, 7 pages.

Weatherford, “Hydraulic-Release Hookup Nipple Circulating Gravel-Pack System,” obtained from www.weatherford.com, (c) 2005, 2 pages.

Weatherford, “Conventional Well Screens,” obtained from www.weatherford.com, (c) 2004-2009, 16 pages.

Weatherford, “Model WFX Setting Tools,” obtained from www.weatherford.com, (c) 2007-2008, 2 pages.

Weatherford, “Model WFX Crossover Tool,” obtained from www.weatherford.com, (c) 2007-2008, 2 pages.

Weatherford, “Real Results: Completion Package Eliminates Sand Production, Enhances Reliability in Siberian Oil-Production Well,” obtained from www.weatherford.com, (c) 2009, 1 page.

Decision on Grant in counterpart Russian Appl. No. 2011143515, dated Mar. 7, 2013.

First Office Action received in counterpart Canadian Appl. No. 2,755,623, dated Jun. 14, 2013.

First Office Action received in counterpart Australian Appl. No. 2011236063, dated May 21, 2013.

First Office Action received in counterpart U.S. Appl. No. 12/913,981, dated May 6, 2013.

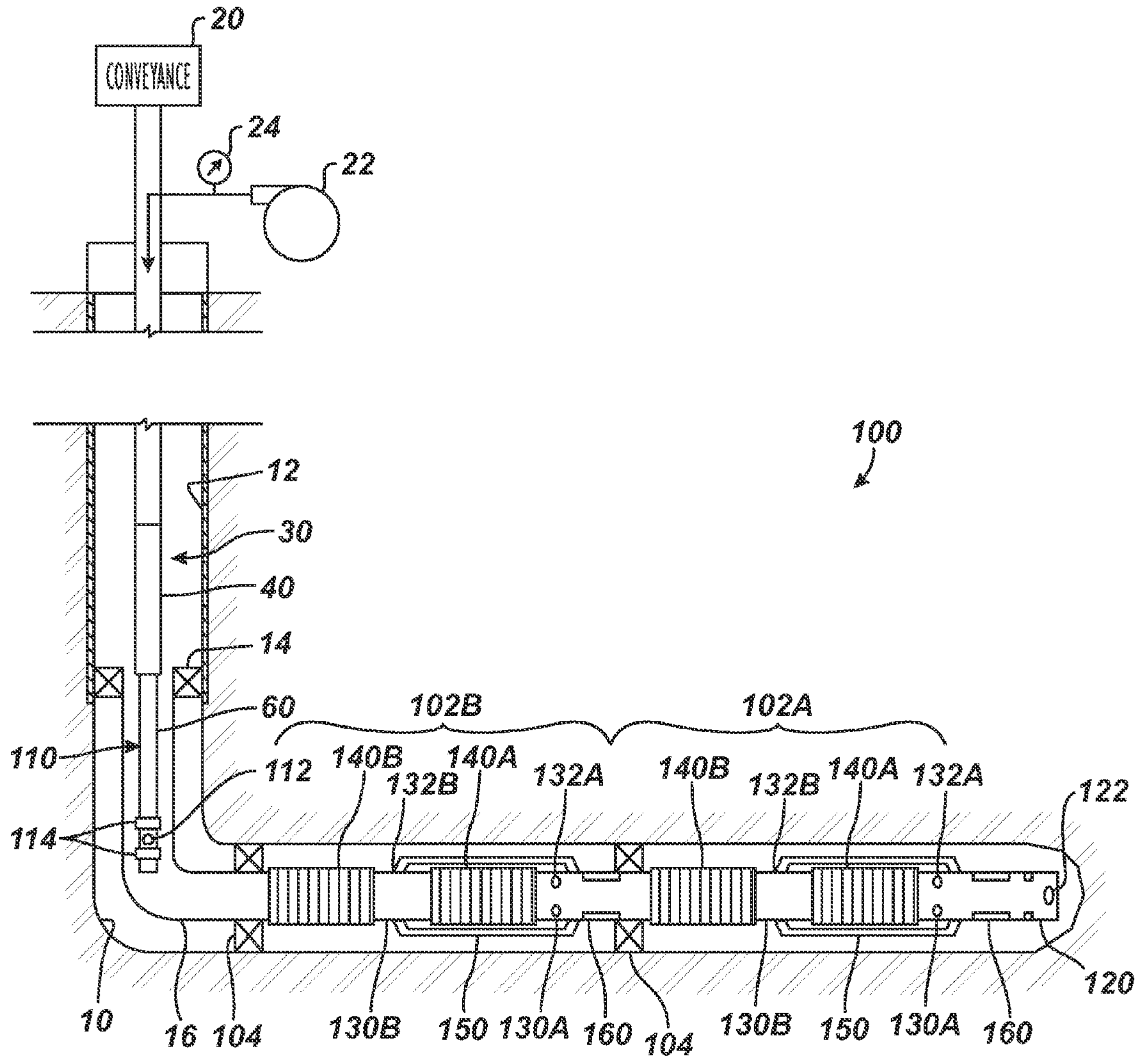
Response to First Office Action received in counterpart U.S. Appl. No. 12/913,981, dated May 6, 2013.

Extended Search Report received in counterpart European Appl. No. 12184724.8, dated Jan. 9, 2013.

International Search Report and Written Opinion in corresponding PCT Application No. PCT/US2013/020246 dated Jan. 3, 2014.

First Office Action in counterpart Russian Appl. No. 2011143515, dated Nov. 26, 2012.

* cited by examiner



20
CONVEYANCE
24
22
100
12
30
40
14
60
102B
102A
110
112
140B
132B
140A
132A
140B
132B
140A
132A
122
114
10
16
104
130B
150
130A
160
104
130B
150
130A
160
120

FIG. 1

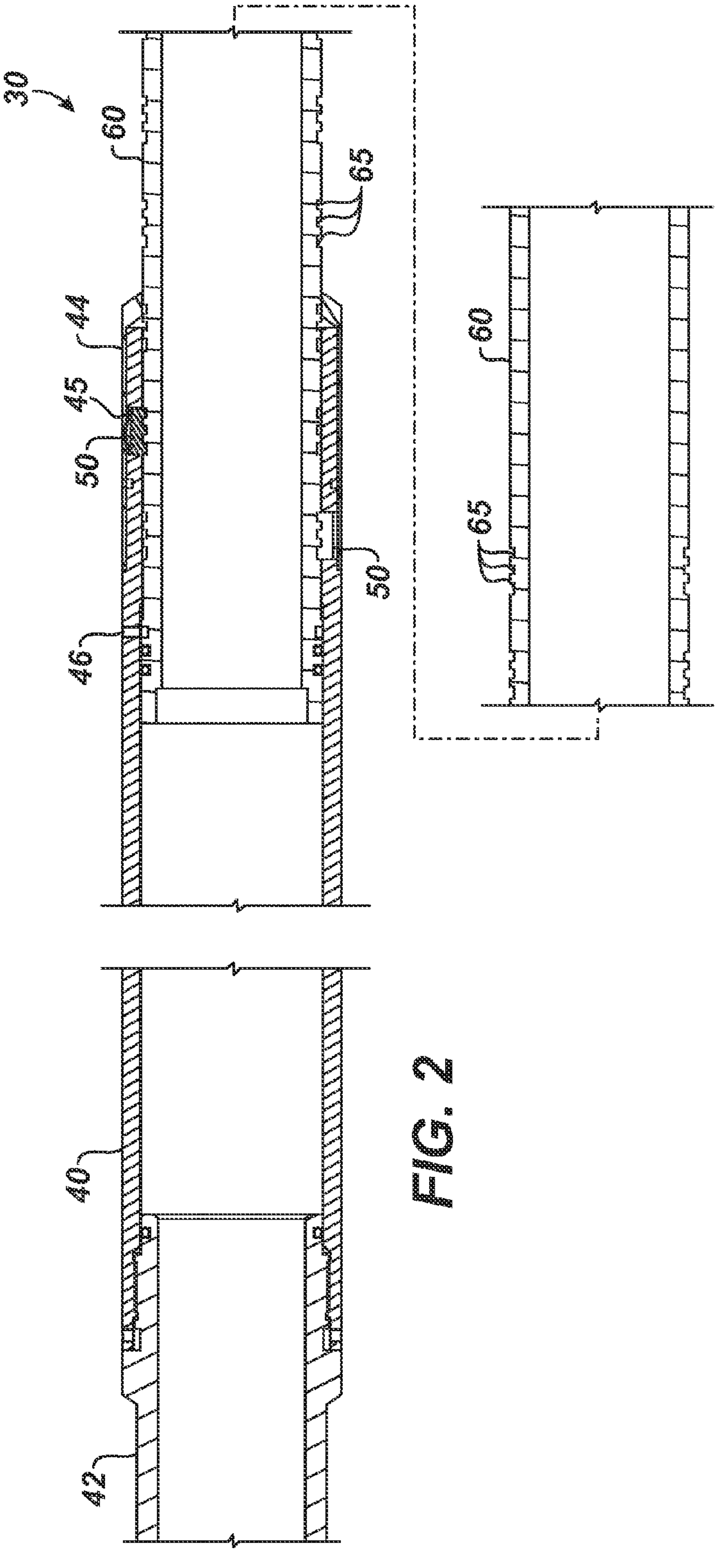


FIG. 2

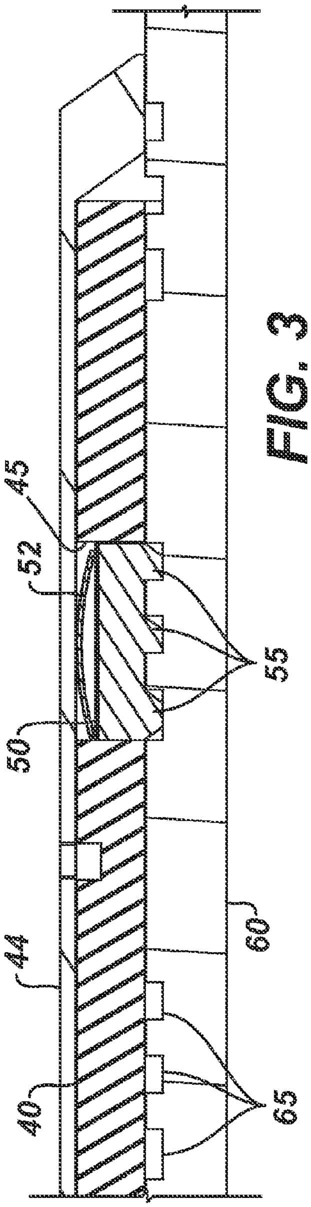


FIG. 3

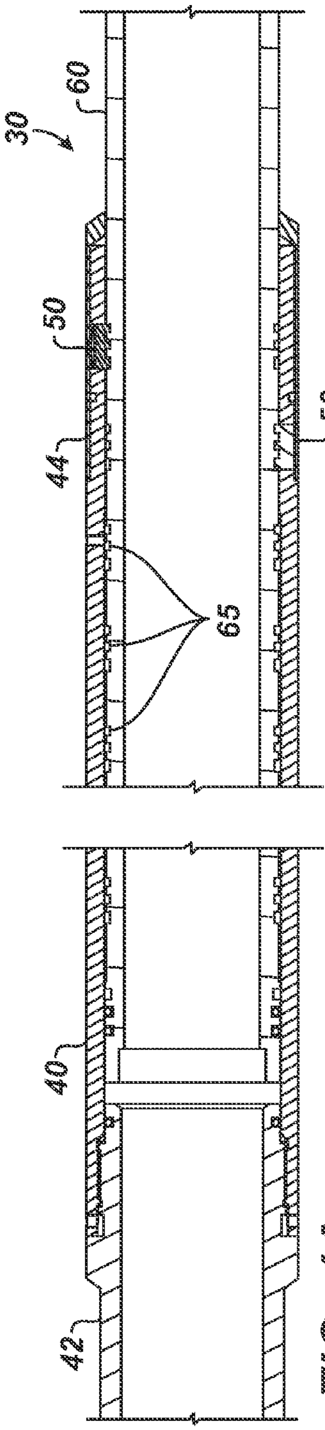


FIG. 4A

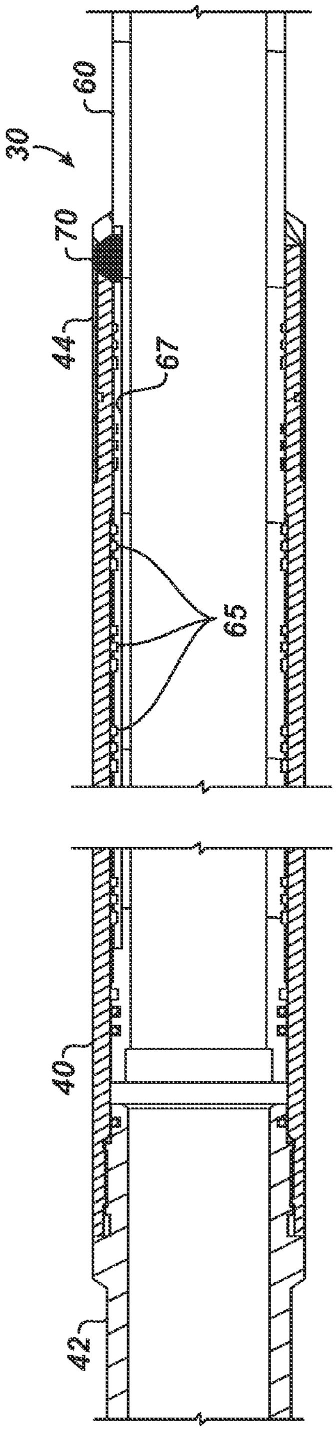
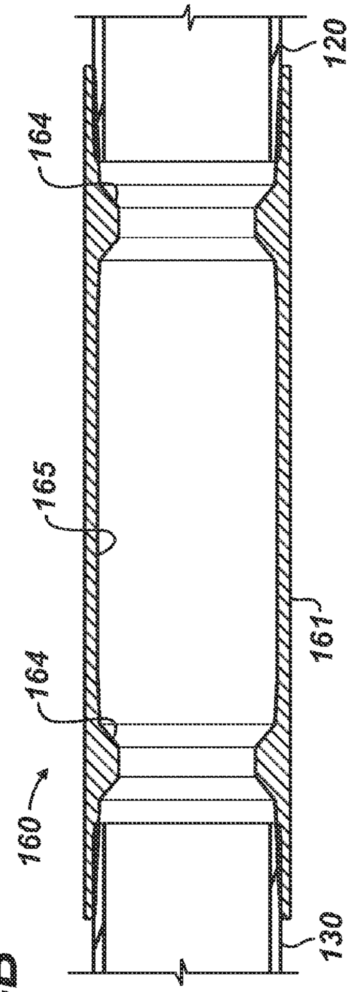


FIG. 4B

FIG. 6



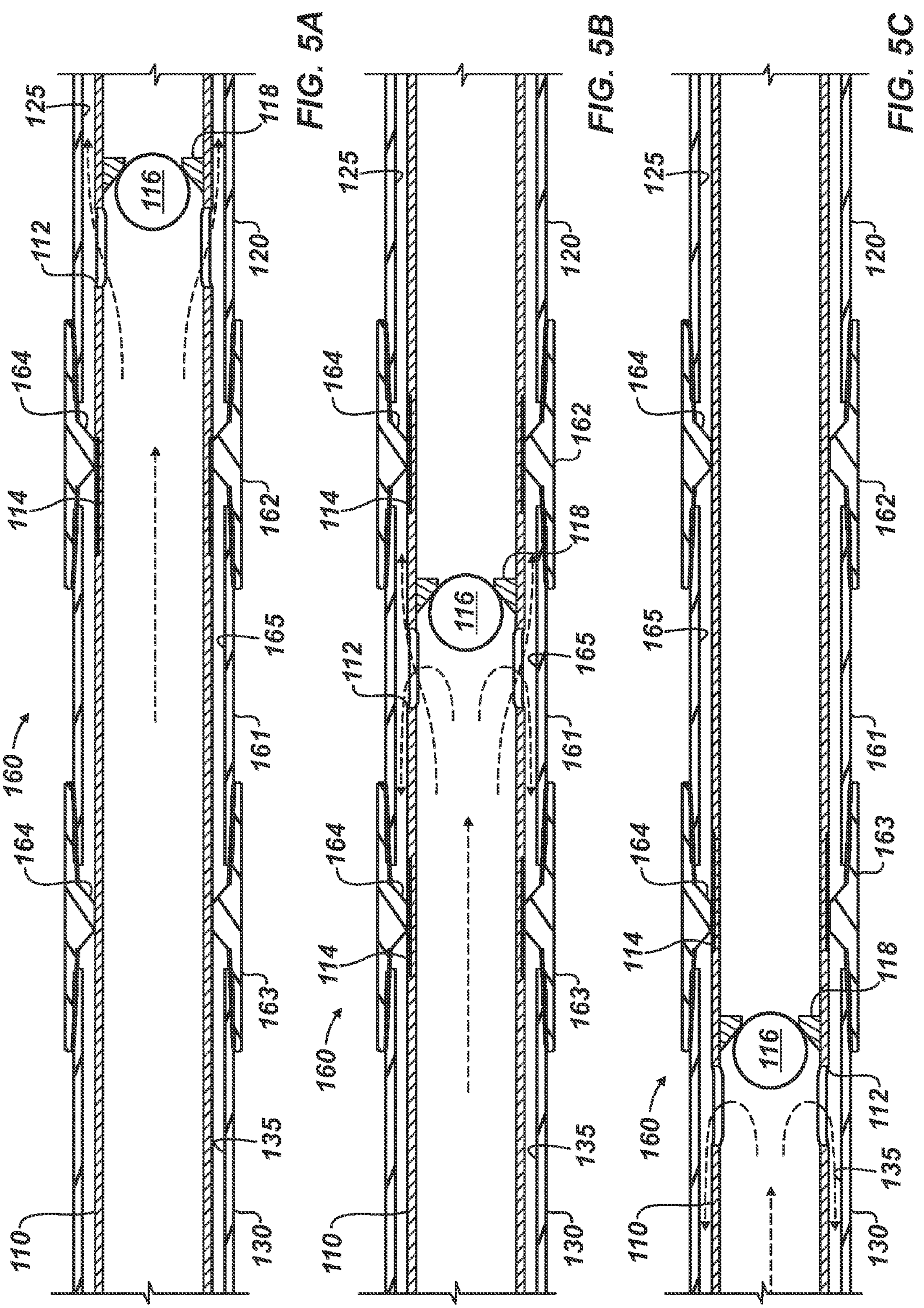


FIG. 5A

FIG. 5B

FIG. 5C

GRAVEL PACK INNER STRING ADJUSTMENT DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of U.S. Appl. Ser. No. 12/913,981, filed 28 Oct. 2010, which is incorporated herein by reference in its entirety and to which priority is claimed.

This application is filed concurrently with U.S. Pat. Appl. Ser. No. 13/345,418 and entitled "One Trip Toe-to-Heel Gravel Pack and Liner Cementing Assembly," U.S. Pat. Appl. Ser. No. 13/345,500 and entitled "Gravel Pack Bypass Assembly," and U.S. Pat. Appl. Ser. No. 13/345,544 and entitled "Gravel Pack Inner String Hydraulic Locating Device," which are also incorporated herein by reference in their entireties.

BACKGROUND

Some oil and gas wells are completed in unconsolidated formations that contain loose fines and sand. When fluids are produced from these wells, the loose fines and sand can migrate with the produced fluids and can damage equipment, such as electric submersible pumps (ESP) and other systems. For this reason, completions can require screens for sand control.

Horizontal wells that require sand control are typically open hole completions. In the past, stand-alone sand screens have been used predominately in these horizontal open holes. However, operators have also been using gravel packing in these horizontal open holes to deal with sand control issues. The gravel is a specially sized particulate material, such as graded sand or proppant, which is packed around the sand screen in the annulus of the borehole. When applied, the gravel acts as a filter to keep any fines and sand of the formation from migrating with produced fluids.

In a gravel pack assembly for a horizontal open hole, proper linear spacing of an inner service tool relative to outer components of the assembly can be particularly important. Operators typically run fixed pipe lengths down the assembly and rely on pipe tallies and available pipe lengths to determine the correct space out for the service tool in the assembly. Unfortunately, the lengths of any screens and the service tool in the horizontal open hole can be considerable, and relying on pipe tallies to achieve correct spacing may prove difficult.

Additionally, the service tool for a gravel pack assembly is typically moved to perform various functions during gravel pack operations. Due to well depth, deviation, tubing stretch, friction, and the type of gravel pack completion to be run, determining the position of the service tool downhole in the assembly can be very difficult. This is especially true in long horizontal gravel pack completions. In the end, pumping of sand slurry when the tool is in an incorrect position in the assembly can cause the service tool to stick and can have catastrophic consequences.

Typically, mechanical indicating collets have been used in the prior art to locate the service tool in the assembly. Additionally, "smart" collets have been used, which reciprocate between a relaxed position and a propped position for positive identification of the service tool's location. Unfortunately, mechanical indication may not always work due to high drag forces and other issues involved in moving the service tool in the downhole assembly.

The subject matter of the present disclosure is directed to overcoming, or at least reducing the effects of, one or more of the problems set forth above.

SUMMARY

As noted above, proper linear spacing of an inner service tool relative to outer components of a downhole assembly can be particularly important. To deal with this issue, an adjustment device is used to adjust a length of an inner string deployed in a downhole assembly, such as a toe-to-heel gravel pack assembly. The device has first and second (tubular) members telescopically coupled together. The first member is coupled to one portion of the inner string, while the second member is coupled to another portion of the inner string. A ratchet disposed on the first member can engage a catch on the second member to fix the length of the adjustment device. The ratchet can include a dog having a plurality of chamfered teeth. The catch, which is movable relative to the ratchet, can include a plurality of grooves defined around the outside of the second member to engage the teeth of the ratchet dog.

The inner string and device are deployed in the downhole assembly to determine proper space out of the inner string for subsequent operation, such as gravel packing. When deployed, the first and second members of the device are in an extended condition. When the inner string eventually bottoms out in the assembly, the ratchet allows the second member to move in one direction relative to the first member so the device can collapse and shorten the length of the inner string. A key between the two members can ride in a slot, which allows the two members to slide relative to one another but not rotate.

When the inner string is then pulled up from the downhole assembly, the ratchet engages the catch (i.e., the teeth on the dog engages in the grooves) to prevent the second member from moving in an opposite direction relative to the first member. In this way, the device does not extend again as the inner string is pulled uphole so the device is maintained in one fixed length.

When the device is brought to the surface, operators can permanently maintain the adjustment device in its fixed length determined downhole by installing a locking element between first and second telescoping members. For example, operators can replace the ratchet dogs with chamfered teeth with locking dogs having unchamfered teeth. Engaged in the grooves of the catch, the locking dog will prevent movement of the second member in either direction inside the first member.

As noted previously, knowing the location of a downhole inner string in a downhole assembly can facilitate operations. To deal with this issue, a downhole assembly, such as a gravel pack assembly, has a body defining a body passage therethrough. First sealing surfaces or seats disposed in the body passage separate a sealable space in the body passage. For example, these seats can be polished surfaces in the body passage having a smaller diameter than the rest of the passage.

An inner string, such as an inner string of a gravel pack assembly, is movably disposed in the body passage and defines a bore for communicating fluid from a surface pump to an outlet port on the inner string. A valve in the bore can divert the pumped fluid out the outlet port.

First seals disposed on the inner string selectively seal with the first seats when the inner string is moved in the body. When this occurs, the outlet port communicates the pumped fluid into the sealable space of the body, which produces a measurable pressure buildup. Using the pressure buildup as an indication, a first position of the inner string can then be

correlated to the known location of the sealable space in the downhole assembly. A second position for the inner string in the body can then be calculated based on a known distance in the downhole assembly from the first location to a second location of another feature, such as a port in the assembly. Being able to determine positions for the inner string allows operators to more properly position the inner string to desired locations in the downhole assembly during gravel pack or other operations.

The foregoing summary is not intended to summarize each potential embodiment or every aspect of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a gravel pack assembly having an adjustment device and a hydraulic locating device for an inner string.

FIG. **2** shows a cross-section of an adjustment device according to the present disclosure.

FIG. **3** shows a detail of a ratchet dog and grooves for the disclosed adjustment device.

FIGS. **4**A-**4**B shows the adjustment device in a fully collapsed state along different cross-sectional planes.

FIG. **5**A shows portion of the assembly and locating device in an initial stage of engagement.

FIG. **5**B shows portion of the assembly and locating device in a sealed stage of engagement.

FIG. **5**C shows portion of the assembly and locating device in a subsequent stage of engagement.

FIG. **6** shows portion of the assembly having another locating device with an integral housing.

DETAILED DESCRIPTION

A. Downhole Assembly

FIG. **1** shows a downhole assembly **100** having an adjustment device **30** and a locating device **160** according to the present disclosure. As shown, the downhole assembly **100** is a gravel pack assembly, although other type of assemblies used downhole can benefit from the disclosed devices **30** and **160**. As one example, a cementing assembly for cementing a liner in an open borehole may benefit from the disclosed devices **30** and **160**. With the benefit of the present disclosure, other suitable downhole assemblies for one or both of the devices **30** and **160** will be apparent to one of ordinary skill in the art.

The gravel pack assembly **100** has multiple gravel pack sections **102**A-B, but the assembly **100** can generally have one or more sections. With multiple sections **102**A-B, however, the assembly **100** segments compartmentalized reservoir zones so that multiple gravel pack and frac pack operations can be performed in the borehole **10**. Isolating elements **104**, such as packers, can dispose between these gravel pack sections **102**A-B to isolate them from one another.

In any event, the gravel pack assembly **100** can be similar to the gravel pack assemblies disclosed in incorporated U.S. application Ser. No. 12/913,981. As such, the gravel pack assembly **100** is a toe-to-heel gravel pack system that allows operators to pack the borehole **10** from the toe to heel in each section **102**A-B. In the depicted configuration, each gravel pack section **102**A-B has two screens **140**A-B, alternate path devices or shunts **150**, and ported housings **130**A-B with ports **132**A-B, although any of the other disclosed variations can be used.

Briefly, gravel pack operations with the assembly **100** involve initially deploying an inner string **110** into the first gravel pack section **102**A. A conveyance **20** manipulates the inner string **110** and can use any of the conveyance methods known in the art. During operations, a pumping system **22** can pump fluid and/or slurry for a gravel or frac pack operation down the inner string **110** as needed, and a pressure sensor **24** can detect a buildup of pressure caused by the pumped fluid. Many of these features are conventional components and are not described in detail here.

Once the inner string **110** is deployed in the assembly **100**, the uphole packer **14** on a liner hanger and other packers **104** along the assembly **100** remain unset. Operators pump washdown fluid through the inner string **110**, and the circulated fluid leaves the string's outlet ports **112** and passes through a float shoe **122** of a shoe track **120** at the end of the first section **102**A. In washing down the borehole **10**, the circulated fluid passes through the annulus and uphole so the fluid can enter the casing **12** and return to the surface.

After washdown and setting of the packers **14** and **104**, the assembly **100** can commence with gravel pack operations. The string's outlet ports **112** with its seals **114** isolate in fluid communication with the lower flow ports **132**A in the first housing **130**A of the first section **102**A. Positioning the string's ports **112** with the flow ports **132**A requires operators to calculate distances and determine the string's position in the assembly **100** relative to the ports' locations. To help with these procedures, the assembly **100** uses a hydraulic locating device **160** as discussed in detail below. As shown, the device **160** is preferably located between the shoe track **120** and the ported housing **130**A.

With the string's ports **112** communicating with the first ports **132**A, slurry can then be pumped down the inner string **110** to gravel and frac pack the surrounding zone of the borehole **10**. As the slurry enters the surrounding borehole annulus, gravel packing of the first section **102**A occurs in a toe-to-heel arrangement as discussed in detail in incorporated U.S. application Ser. No. 12/913,981.

Once sandout occurs at this port **132**A, the inner string **110** can again be moved so that the outlet ports **112** isolate to upper flow ports **1328** connected to the shunts **150** in this first section **102**A. Slurry pumped down the inner string **110** can then fill the borehole annulus around the lower end of the shoe track **120**, which can be done to further pack the borehole **10** or to dispose of excess slurry from the string **110**.

Operations can then proceed with similar steps being repeated up the borehole **10** for each of the subsequent gravel pack sections (e.g., **102**B) separated by the intervening packers **104**. Again, additional details and steps in the operation of the toe-to-heel gravel pack system **100** of FIG. **1** are provided in incorporated U.S. application Ser. No. 12/913,981 so they are not repeated here in detail.

B. Adjustment Device

As noted previously, proper linear spacing of a service tool relative to outer assembly components can be important, especially in a horizontal open hole. Rather than running fixed pipe lengths and relying on a pipe tally and available pipe lengths to achieve correct space out for the inner string **110**, operators make up the adjustment device **30** on the inner string **110** above the outlet ports **112** and seals **114**. The device **30** allows operators to achieve proper spacing, which is even more critical in the toe-to-heel assembly **100** of the present disclosure.

Notably, the inner string **110** in this toe-to-heel assembly **100** first locates at the bottom of the shoe track **120** to communicate washdown fluid out the float shoe **122** as described above. The gravel pack operation then proceeds with the inner string **110** being moved to a number of flow ports **132** along the assembly **100**. If the inner string **110** is not run or spaced out properly, then operations will not proceed effecting, and the assembly **100** may become damaged.

To help space out the inner string **110**, the adjustment device **30** has an upper member **40** with a distal member **60** telescopically disposed therein. Thus, the distal member **60** is linearly expandable and collapsible relative to the upper member **40**. Before actually commencing gravel pack operations, operators make up the device **30** in its extended condition on the inner string **110** and then run the inner string **110** and the expanded adjustment device **30** downhole. Eventually, the inner string **110** tags against the bottom of the gravel pack assembly **100**, and the adjustment device **30** collapses until the upper member **40** of the adjustment device **30** (or some other portion of the inner string **110**) shoulders out. At this point, the inner string **110** has obtained its proper space out length in the assembly **100**.

At the surface, operators mark the exposed pipe to indicate the extent of pipe used during run-in, and operators then raise the adjustment device **30** and inner string **110** back out of the well. As the adjustment device **30** is pulled uphole, the device **30** at least temporarily locks in position so the adjustment device **30** maintains a fixed length. At the surface, operators then fix the current length of the adjustment device **30** to prevent further adjustment. Finally, operators run the inner string **110** and fixed device **30** back downhole into the assembly **100**, and the determined space out will put the bottom of the inner string **110** in the desired location in the first gravel pack section **102**A, as needed.

FIG. **2** shows the adjustment device **30** in more detail. As noted previously, the device **30** includes an upper (tubular) member **40** and a distal (tubular) member **60** telescopically disposed therein. Although the device **30** is shown with two telescoping members **40** and **60**, more members could be used.

At its uphole end, the upper member **40** has a coupling **42** that couples to uphole components (not shown), such as an uphole portion of the inner string (**110**). The distal member **60** extends from the upper member's downhole end, and the two members **40** and **60** may be initially held in an extended condition by shear pins **46** or the like. Ratchet dogs **50** are disposed in slots **45** around the outside of the upper member **40**, and a retaining sleeve **44** disposed on the upper member **40** helps hold the ratchet dogs **50** in place. Seals **62** on the distal member **60** engage inside the upper member **40** to inhibit fluid flow between the members **40** and **60**.

The outside of the distal member **60** has catches or grooves **65** spaced apart from one another along most of the member's length. The actual length of the members **40** and **60** can be much greater than depicted in FIG. **2** so that the distal member **60** can expand and collapse a considerable distance as need for an implementation.

In FIG. **2**, the device **30** is shown extended as when it is initially run downhole. When fully extended, the ratchet dogs **50** engage in the topmost catch grooves **65** on the distal member **60**. After the device **30** locates on bottom in the assembly **100**, the members **40** and **60** collapses, and the ratchet dogs **50** ratchet up the catch grooves **65** on the distal member **60**.

FIG. **3** shows a detail of the ratchet dogs **50** engaging in catch grooves **65** on the distal member **60**. The ratchet dogs **50** have a number of teeth **55** with chamfered leading edges. As the distal member **60** moves into the upper member **40**, the chamfered teeth **55** let the catch grooves **65** pass thereby.

Springs **52** disposed behind the ratchet dogs **50** bias them toward the surface of the distal member **60** so the teeth **55** can engage in the catch grooves **65**. The springs **52** can be leaf springs or other types of biasing elements. Preferably, the catch grooves **65** are arranged in sets to engage the multiple teeth **55** on the ratchet dogs **50**, but it will be appreciated that a number of ratcheting mechanisms can be used, including those conventionally used in downhole tools for packers or sliding sleeves.

As the inner string **110** is disposed in the assembly **100** and engages bottom, the members **40** and **60** collapse together until the upper member **40** (or some other part of the inner string **110**) shoulders out in the assembly **100**. Shouldering can be achieved in a number of ways. For example, the assembly **100** can have a restricted passage that allows the distal member **60** to pass therethrough when bottoming out in the assembly **100**, but the restricted passage engages the upper member **40** when moved against it.

Once the device **30** is collapsed and shoulders out, operators pull up the inner string **110** to the surface. Operators remove the retaining sleeve **44** and replace the ratchet dogs **50** with locking dogs (not shown) in the slots **45**. These locking dogs (not shown) can be similar to the ratchet dogs **50**, but they lack ratcheting chamfers so the locking dogs will not ratchet in the distal member's catch grooves **65**. Operators then make up the sleeve **44** so the locking dogs are held and distal member **40** is permanently locked in position. At this point, operators can redeploy the inner string **110** with the device **30** in its fixed length downhole to proceed with gravel pack operations.

FIGS. **4**A-**4**B show different cross-sections of the adjustment device **30** in a fully collapsed position. FIG. **4**A shows the ratchet dogs **50** disposed in the upper member **40** for engaging the outer catch grooves **65** in the distal member **60**. In general, one or more such dogs **50** can be used, but the dogs **50** are preferably arranged consistently about the circumference of the members **40** and **60**, although they need not be at the same longitudinal location.

FIG. **4**B shows a key **70** disposed in the upper member **40** and held by the sleeve **44**. The key **70** rides within a longitudinal groove **67** along a length of the distal member **60**. Thus, the two members **40** and **60** can slide relative to one another, but the key **70** prevents rotation of the members **40** and **60** relative to one another. Although one key **70** is shown, more than one key **70** may be used.

C. Locating Device

As can be seen in the toe-to-heel gravel pack assembly **100** of FIG. **1**, the inner string **110** runs to the very bottom of the assembly **100** to the shoe track **120** for washdown during gravel pack operations. Then, the inner string **110** is manipulated in the assembly **100** to a number of ports **132**A-**132**B and other positions to perform the gravel pack operations in the various sections **102**A-B. As will be appreciated, knowing the location (distance) of various features (ports, etc.) relative to the position of the inner string **110** in the assembly **100** can help operators move and position the inner string **110** properly and effectively in the assembly **100** during operations.

To that end, the gravel pack assembly **100** includes one or more locating device **160** disposed thereon for locating the inner string **110** at different positions in the assembly **100**. As shown in FIG. **1**, one of the locating devices **160** can be disposed near the shoe track **120** between the float shoe **122** and the first ports **132**A on the ported housing **130**A of the first section **102**A. Having the device **160** in this location allows operators to correlate the inner string's position to at least one location in the assembly **100**, and preferably the furthest location. As will be appreciated, the length of the assembly **100**, the length of the inner string **110** to reach the assembly's end, drag forces, friction, possible deflection, and other factors may make conventional techniques for locating the inner string **110** in the assembly **100** difficult. Therefore, having the locating device **160** in this distal location of the assembly **100** can be beneficial for determining other positions for the inner string **110** in the assembly **100**.

Knowing this one location of the device **160** at the distal extent and knowing the details and dimensions of the assembly **100** disposed downhole, operators can then calculate distances to other locations (i.e., ports **132**A-B) on the assembly **100** so other positions for the placement of the inner string **110** can be determined. If desired, the locating device **160** could be located elsewhere on the assembly **100**.

Moreover, more than one locating device **160** can be used on the assembly **100** so several locations can be determined along the assembly **100** during operations. For example, each section **102**A-B of the assembly **100** can have a comparable locating device **160** so positions for the inner string **110** can be determined at multiple locations when performing operations. In the end, this can help operators find the various ports **132**A-B individually in the sections **102**A-B.

Rather than using mechanical techniques for location, which can be unreliable, the locating device **160** uses hydraulic techniques for locating the position of the inner string **110** in the assembly **100**. Turning to FIGS. **5**A-**5**C, portion of the assembly **100** is shown with the inner string **110** disposed in a locating device **160**. Here, the locating device **160** includes a tubular **161** connected by a downhole coupling **162** to the shoe track **120** and connected by an uphole coupling **163** to a ported housing **130**. Again, the device **160** could be located elsewhere on the assembly **100**, in which case the couplings **162**, **163** would couple to other components, such as between uphole and downhole sections **102**A-B of the assembly **100**.

Rather than using separate couplings **162**, **163** as shown, the device **160** can be an integral component as shown in FIG. **6** having its tubular housing **161** with coupling members formed thereon. Either way, the device **160** of FIGS. **5**A-**5**C and **6** has an inner passage **165** that is in fluid communication with passages **135** and **125** of the housing **130** and shoe track **120**. The inner passage **165** forms a sealable space with internal sealing surfaces or seats **164** disposed at both ends. These seats **164** can be internal polished surfaces with a reduced diameter from the other passages **125**/**135**/**165**.

The inner string **110** has external seals **114** disposed one each side of outlet ports **112**. The seals **114** are adapted to engage the inner polished seats **164** of the couplings **161**, **163** as discussed below. (A reverse arrangement may also be used in which the couplings **161**, **163** have internal seals for engaging polished surfaces or seats on the inner string **110**.) As shown here, the inner string **110** also includes a valve (i.e., seat **116** and dropped ball **118**) that can close off fluid flow down the string **110** and divert the flow out the outlet ports **112**. Other valve arrangements could also be used, or the distal end of the inner string **110** can be permanently closed off.

As shown in FIG. **5**A, as the inner string **110** passes uphole in the assembly **100** from the shoe track **120** (or a lower section **102**) to the locating device **160**, circulated fluid is pumped slowly down the string **110** and is diverted out the outlet ports **112**. (In general, the circulated fluid can be any suitable fluid used during gravel/frac pack operations. Preferably, the circulated fluid is water, brine, or some other type of carrying or washdown fluid. Although less desirable, the circulated fluid could include gravel packing slurry or frac treatment.)

As it is pumped, the circulated fluid can flow downhole in the annulus between the string **110** and assembly **100** (i.e., shoe track **120** and other downhole component). Eventually as shown in FIG. **5**A, the upper seal **114** of the string **110** engages the lower seat **164** of the locating device **160**.

With further uphole movement of the string **110** as shown in FIG. **5**B, the outlet ports **112** reach the inner passage **165** of the device **160**, and the seals **114** engage the seats **164**. This creates a sealed space of the passage **165** in the device **160** that is isolated from uphole and downhole portions of the assembly's inner passages **135** and **125**. The sealing between the seals **114** and the seats **164** may be intended to inhibit flow and may not necessarily create a fluid tight seal.

As the string **110** reaches this sealable space of the passage **165**, fluid pumped slowly down the inner string **110** to the string's outlet ports **112** creates a measurable buildup in pressure, which can be detected by the pressure sensor (**24**) at the surface or elsewhere on the assembly **100**. Further movement of the string **110** uphole eventually moves the seals **114** out of the device **160** as shown in FIG. **5**C. At this point, the circulated fluid can exit the outlet ports **112** and can pass up the annulus so there is no more measurable pressure buildup.

When the pressure buildup occurs with the string's ports **112** sealed at the locating device **160**, operators can identify this buildup and can associate the string's current position with the location of the device **160** on the assembly **100**. From this known location and the known dimensions and configuration of the assembly **100** deployed downhole, other position for positioning the inner string **110** can be calculated for other desired locations on the assembly **100**. Movement to these other positions can be easily achieved by further moving the inner string **110** the calculated distances to the other locations of the assembly **100**.

The locating device **160** works regardless of the amount of pipe and drag in the inner string **110** when manipulated in the assembly **100**. Therefore, at any time during operations, this known location of the device **160** can be found by movement of the string **110** and slow pumping until indication is observed so calculations to other locations can be determined.

Movement of the inner string **110** in the assembly **100** of FIGS. **5**A-**5**C has been uphole. The locating device **160**, however, can operate equally as well with downhole movement of the string **110** in the device **160**. Furthermore, although the locating device **160** has been used on a particular gravel pack assembly **100** in which gravel packing occurs from toe-to-heel, the features of the locating device **160** and inner string **110** can be used on any suitable downhole assembly in which circulated fluid from a port on the string **110** can help locate the string's position in the locating device **160** and further help determine other positions for the string **110** in the downhole assembly. For example, the locating device **160** could be used with a conventional gravel pack assembly and a crossover tool, or the locating device **160** could be used with a cementing assembly and a service tool. Additionally, the locating device **160** can be helpful in locating an inner string in a number of downhole components, such as locating in an extend reach frac pack assembly, a multi-zone frac system, an inflatable packer, and others. Accordingly, the above-description directed to the particular gravel pack assembly **100** is meant to be illustrative of a particular application of the disclosed subject matter.

The foregoing description of preferred and other embodiments is not intended to limit or restrict the scope or applicability of the inventive concepts conceived of by the Applicants. It will be appreciated with the benefit of the present disclosure that features described above in accordance with any embodiment or aspect of the disclosed subject matter can be utilized, either alone or in combination, with any other described feature, in any other embodiment or aspect of the disclosed subject matter.

In exchange for disclosing the inventive concepts contained herein, the Applicants desire all patent rights afforded by the appended claims. Therefore, it is intended that the appended claims include all modifications and alterations to the full extent that they come within the scope of the following claims or the equivalents thereof.

What is claimed is:

1. A method of spacing an inner string in a downhole assembly, the downhole assembly disposed in a borehole and having at least one first port for fluid communication out of the downhole assembly, the inner string deploying in the downhole assembly and having at least one second port for fluid communication out the inner string, the method comprising:

installing an adjustment device on the inner string for running downhole, the adjustment device being collapsible to a plurality of fixed lengths;

deploying the adjustment device and the inner string downhole in the downhole assembly;

adjusting a length of the inner string while downhole by collapsing the adjustment device to one of the fixed lengths when bottoming out the inner string in the downhole assembly;

pulling up the adjustment device and the inner string in the downhole assembly;

maintaining the adjustment device in the one fixed length; and

positioning the adjustment inner string in the downhole assembly with the at least one second port of the inner string spaced out a known distance relative to the at least one first port.

2. The method of claim **1**, wherein deploying the adjustment device and the inner string downhole in the downhole assembly comprises deploying the adjustment device in an extended condition.

3. The method of claim **1**, wherein maintaining and positioning comprises locking the adjustment device in the one fixed length and redeploying the inner string with the adjustment device in the locked length.

4. The method of claim **1**, wherein collapsing the adjustment device to one of the fixed lengths comprises telescoping a first member of the adjustment device into a second member of the adjustment device.

5. The method of claim **4**, wherein maintaining the adjustment device in the one fixed length comprises catching the first member in the one fixed length in the second member.

6. The method of claim **4**, wherein maintaining the adjustment device in the one fixed length comprises installing a locking element between first and second telescoping members of the adjustment device.

7. The method of claim **4**, further comprising preventing rotation of the first and second members relative to one another.

8. The method of claim **1**, further comprising:

positioning the at least one second port on the adjusted inner string relative to the at least one first port; and

conducting fluid from the at least one second port to the at least one first port.

9. A device for an inner string deploying in a downhole assembly, the downhole assembly disposed in a borehole and having at least one first port for fluid communication out of the downhole assembly, the inner string deploying in the downhole assembly and having at least one second port for fluid communication out the inner string, the device comprising:

a first member coupled to one portion of the inner string;

a second member telescopically coupled to the first member and coupled to another portion of the inner string;

at least one ratchet disposed on the first member; and

at least one catch disposed on the second member and movable relative to the at least one ratchet,

wherein the at least one ratchet allows the second member to move in one direction relative to the first member,

wherein the at least one ratchet engages in the at least one catch and prevents the second member from moving in an opposite direction relative to the first member, and

wherein the first and second members adjust a length of the inner string and space out the at least one second port of the inner string a known distance for positioning relative to the at least one first port of the downhole assembly.

10. The device of claim **9**, wherein the at least one ratchet comprises a dog having at least one tooth with a chamfer in the one direction.

11. The device of claim **10**, wherein the at least one catch comprises a groove defined on the second member and engaging the at least one tooth of the dog in an opposite direction.

12. The device of claim **11**, wherein the dog has a plurality of the at least one tooth, and wherein the at least one catch has a set of the at least one groove engaging the teeth of the dog.

13. The device of claim **9**, wherein the at least one catch comprises a plurality of grooves defined along a length of the second member and engageable with the at least one ratchet in a number of fixed lengths of the second member relative to the first member.

14. The device of claim **9**, further comprising:

a slot defined on one of the first and second members; and

a key disposed on the other of the first and second members and movable in the slot, the key in the slot preventing rotation of the first and second members relative to one another.

15. The device of claim **9**, wherein the device and the adjusted inner string position downhole to conduct fluid from the at least one second port of the inner string to the at least one first port of the downhole assembly.

16. A device for an inner string deploying in a downhole assembly, the downhole assembly disposed in a borehole and having at least one first port for fluid communication out of the downhole assembly, the inner string deploying in the downhole assembly and having at least one second port for fluid communication out the inner string, the device comprising:

a first member coupled to one portion of the inner string;

a second member telescopically coupled to the first member and coupled to another portion of the inner string; and

means for adjusting a length of the inner string while downhole comprising:

means for collapsing the second member relative to the first member to one of a plurality of fixed lengths,

means for ratcheting movement of the first member in one direction relative to the second member,

means for preventing movement of the second member in an opposite direction relative to the first member, and

means for spacing out the at least one second port a known distance for positioning relative to the at least one first port.

17. The device of claim **16**, further comprising means for preventing rotation of the first and second members relative to one another.

18. The device of claim **16**, further comprising means for locking the first and second members in the one fixed length.

19. The device of claim **16**, further comprising means for positioning the adjusted inner string in the downhole assembly to conduct fluid from the at least one second port of the inner string to the at least one first port of the downhole assembly.

* * * * *